NAVAL POSTGRADUATE SCHOOL
Monterey, California

EC 3550 MIDTERM EXAM II 11/90Po

- This exam is open book and notes.
- There are three problems; each is equally weighted.
- Partial credit will be given; be sure to do some work on each problem.
- Be *sure* to include units in your answers.
- Please circle or underline your answers.
- Do *NOT* do any work on this sheet.
- Show *ALL* work.

1	
2	
3	
Total	

Name: _____

1. A silicon avalanche photodiode reverse–biased with 150 volts produces an output current of 10 μA when irradiated by 1 μW of optical power at 900 nm. The quantum efficiency of the detector is known to be 50% at this wavelength when $M = 1$.

   Calculate the normalized signal–dependent mean–square shot noise current (in A^2/Hz) for this detector and illumination level if the excess noise factor is $M^{0.4}$.

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2. A silicon avalanche detector is used with a load resistor and preamp that have the following properties to detect a 1.0 μW signal at 900 nm.

Detector		Load resistor		Preamp	
Material	Silicon	Value	300 Ω	Noise figure	8 dB
Type	APD	Noise temperature	380K	Bandwidth	5 MHz
Responsivity ($M = 1$)	0.6 A/W			Current gain	100
Excess noise factor	$M^{0.3}$				
Bulk dark current	1.5 μA				
Surface dark current	100 nA				

   (a) Calculate the optimum value of avalanche gain.

   (b) Calculate the S/N ratio *in dB* for $M = 100$.

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3. An optical source is connected to a 1x4 coupler, a 1.5 km length of fiber, another 1x4 coupler, and a receiver as shown in the figure below. The source, receiver, and couplers all have pigtails of 1 m length. The system uses connectors with a loss of 1.2 dB each. The fiber loss is 1.8 dB/km and the insertion loss of each 1x4 coupler is 2.0 dB for each output.

   If the minimum power required at the receiver is 100 nW, calculate the minimum source power *in* μW that must be coupled into the source fiber.